

# End Results of Thoracolumbar Sympathectomy for Advanced Essential Hypertension

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## SUMMARY

*In a six-year period from February 1942 to February 1948, 473 patients (185 males and 288 females) were operated upon for essential hypertension and most of them were in advanced stages of hypertensive disease.*

*Patients were selected or rejected for operation on the basis of a set of rules drawn to guide clinical judgment.*

*The total of deaths in and out of the hospital over this period was 79 or a total mortality of 16 per cent. There were 38 in-hospital deaths, or a mortality of 8 per cent. The causes of deaths occurring in the hospital were in the following order: cerebral accident, cardiac failure, and renal insufficiency. The out-of-the-hospital deaths were in the following order: cardiac failure, cerebral accident, and renal insufficiency.*

*Operations done early in the series followed the Smithwick procedure from T-9 through L-2, but later the minimal procedure was extended from T-3 through D-3, and in addition about 40 total sympathectomies which included the stellate ganglion were done. Results from the more extensive operation were better than those from the lesser procedure, but the mortality also was greater. Conclusion that complete or nearly complete sympathectomy is preferable to a less extensive procedure must await the collection of more data which can be used in weighing the respective end results against the mortality.*

*Thoracolumbar sympathectomy has a definite place in the treatment of hypertensive vascular disease, but its role in advanced cases is chiefly that of palliation.*

from the eighth or ninth thoracic ganglion through the first or second lumbar ganglion, along the portions of the greater, lesser, and least splanchnic nerves.

In a series of 375<sup>7</sup> thoracolumbar sympathectomies with follow-up of the patients for six months to five years, we had 38 fatalities either in the hospital or within six months following the operation. In an attempt to lower this mortality rate we analyzed the status of the 38 patients who died and that of the 337 surviving patients, and arrived at a set of rules which theoretically would reduce the mortality rate to 2.5 per cent. This figure would be reasonably low in view of the fact that each patient undergoes two major operative procedures and many are recognized as poor risks.

Following the lead of Keith, Wagener and Barker<sup>9</sup> who graded the eyegrounds of hypertensive patients from 0 to 4 plus, we have utilized a similar method for grading the cerebral, cardiac and renal status of each patient. In order to do this satisfactorily we require, in addition to a careful history and physical examination, the following studies: Examination of the fundus, electrocardiography, a 6-foot heart film, a concentration test (pitressin or Mosenthal), urea clearance, blood urea nitrogen, non-protein nitrogen and creatinine determinations and urinalysis. Intravenous urography was applied routinely in the work-up of the first 150 patients until one death and two marked reactions associated with the injection of dye caused us to abandon it unless there was a significant indication for its use.

In Table 1 we have outlined a system of rules which serve to evaluate the degree of damage present in each of the four important organs, brain, eye, kidney, and heart, as a result of the hypertensive state. Any patient with ten or more pluses in all probability should not be operated upon.

A system such as this one, not based on mathematical data, must be interpreted in the light of clinical judgment, and it is implied that the operator has had a moderate amount of experience in the technique of thoracolumbar sympathectomy. The rules have aided us considerably and may be of help to internists and surgeons interested in the surgical treatment of hypertension.

It is very important to the surgeon and the internist to have clear-cut indications for accepting or rejecting these advanced cases for operation. It is our feeling that death occurring six months post-operatively indicates an unwise selection of patients for thoracolumbar sympathectomy. The only exception to this rule is the case in which papilledema has produced total blindness, and operation is per-

THE surgical treatment of hypertension had its origin in the pioneer work of Crile,<sup>3</sup> Adson and Craig,<sup>1</sup> Heuer and Page,<sup>6</sup> Peet<sup>10</sup> and others, but it was not until 1940 when Smithwick<sup>13</sup> first reported his clinical studies that an efficient operative procedure was made known. The method described by Smithwick and employed by him for the past nine years includes removal of the thoracolumbar chain

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TABLE 1.—Rules for Evaluation of Symptoms in Indications for Operation

Symbols Used	Eyes	Cerebrum	Heart	Kidneys
0	Normal	No signs or symptoms	No signs or symptoms	Normal
1 +	Arteriolar narrowing	Headaches and/or dizziness and nervousness	Slight symptoms and/or slight enlargement and slight e.k.g. changes	Nocturia; but concentration 1.024 or more; urea clearance 75% or more
2 +	Arteriolar narrowing and arteriovenous nicking	Headaches and/or nosebleeds and/or occipital headaches and/or dizziness and nervousness	Moderate symptoms and/or moderate x-ray enlargement; moderate e.k.g. changes	Urea clearance 40-75%; concentration 1.015-1.023
3 +	Arteriolar narrowing and arteriovenous nicking and hemorrhages and exudates	Headaches and/or nosebleeds and/or occipital headaches and/or dizziness and paresthesias	Marked symptoms and/or marked enlargement and marked e.k.g. changes	Urea clearance less than 40%; concentration less than 1.015; normal blood chemistry
4 +	Arteriolar narrowing and arteriovenous nicking and hemorrhages and exudates and papilledema	Stroke or encephalopathy or confusion	Coronary occlusion or congestive heart failure	Persistent elevation of n.p.n. to 40 mg. or more and b.u.n. to 20 mg. or more

formed to restore vision. Even when this objective is attained, it must be understood by the patient and his family that life expectancy will not be changed by this procedure.

#### INDICATIONS FOR OPERATION

**Ocular Fundus:** It may be stated categorically that in our experience no changes in the eyegrounds per se, with the exception of marked arteriosclerosis in conjunction with evidence of marked arteriosclerosis elsewhere, are to be thought of as contraindicating operation. Failing vision is in most cases an urgent criterion for operation, often in the face of other findings which ordinarily might be considered as militating against surgical intervention.

**Cerebral Vessels:** The status of the cerebral vessels has been the cause of great concern. Clinically, attempts to predict occlusion or hemorrhage in the vessels of the brain are notoriously futile. However, in our experience, aside from a persistent hemiplegia of less than six months' duration the most dependable evidence of cerebral damage, and therefore a contraindication to operation, is mental confusion, however slight, as evidenced by the usual signs of organic brain defects, particularly recent loss of memory. Such defects were most frequently seen in the presence of other signs of generalized arteriosclerosis. Paresthesias, dizzy spells and headaches are noted in Table 1.

**Cardiac Status:** In considering the cardiac status of a candidate for sympathectomy, the most important consideration (granting a high degree of surgical competence and skillfully conducted anesthesia) is the history of functional cardiac capacity. Cardiac failure is not in itself a contraindication, but when it completely fails to respond to the usual therapeutic procedures it is an absolute contraindication. The electrocardiogram has been of value most frequently in verifying the diagnosis of recent myocardial infarctions. In such instances it has been our policy to defer operative intervention for eight weeks or longer depending on the severity and extent

of the infarction. Evidence of marked left ventricular enlargement has been seen frequently and, other factors being equal, is an indication for operation. Improvement in the electrocardiographic tracing may be expected in a high percentage of cases.

**Renal Status:** Renal decompensation as reflected in elevated circulating nitrogenous waste rules out the advisability of operation, whatever the underlying renal pathologic changes. In reviewing the operation and postoperative mortality data it is apparent that renal pathologic change as determined by elevated blood urea nitrogen above 18-20 mgm. per 100 cc. and nonprotein nitrogen above 40 mgm. per 100 cc. constitutes one of the most reliable preoperative guides from the point of view of both immediate and remote prognosis in hypertensive patients. Of the fatalities, half the hospital deaths, and almost half the postoperative deaths were among patients who had circulating nitrogenous wastes above those levels. This, of course, is a gross test of renal competence, yet for us it has been highly reliable, especially in the absence of other gross evidence of renal damage, such as marked albuminuria, hematuria, and anemia. Borderline levels must be considered in the light of other findings, and the closer the levels are to the upper limits of normal, the less confidence the surgeon has in making a decision. Poor renal concentration alone has not been considered a cause for withholding operation. Urea clearance determinations were done routinely, but their reliability was frequently questionable due to the difficulty of adhering rigidly to the technical requirements of the test. Additional and perhaps more refined tests of renal competence would undoubtedly have revealed evidence of renal damage in other patients with established hypertension, but for purpose of preoperative evaluation their inclusion would seem to offer little of critical value. Intravenous pyelography was rarely of any value and was soon discontinued, except when clinically indicated. In the preoperative evaluation of the status of an organ, problems such as the

following may arise: the renal concentration test may be only 1.013, whereas the urea clearance may be 85 per cent of normal. In that case we have one test placing the kidney in a 3 plus category and the other in a 1 plus. We therefore average the two and consider the degree of damage as 2 plus. Similarly a patient may have excellent cardiac function, that is, he may have no dyspnea, or angina after climbing three flights of steps, and yet the electrocardiograms and x-ray film of the chest may show moderate (2 plus) changes. It is a matter of judgment whether the patient should be classified as having 2 plus or 1 plus cardiac insufficiency.

A complete blood count, a sodium amytal test (9 grains divided into three hourly doses) and a basal metabolism test are desirable but are not emphasized in evaluating the patient's status for sympathectomy. A high basal metabolic rate associated with hypertension is suggestive of pheochromocytoma.

The response of the blood pressure to deep barbiturate sedation or the autonomic blockade, as by tetraethylammonium chloride, is a useful device for testing the capacity for relaxation of the arteriolar bed and theoretically anticipating the result. The sodium amytal test is a good indication of a probable postoperative blood pressure result but is not absolutely accurate as a prognosticator in any given case. In our series no patient was turned down solely on the basis of a poor response to sodium amytal.

The etamon test (tetraethylammonium chloride) has been studied by Poindexter and Tamagna and compared with the sodium amytal test in over 50 patients.<sup>12</sup> In approximately 75 per cent of the cases the two tests correlated exactly while in the remaining 25 per cent there was a variation in both directions. No postoperative evaluation of the usefulness of the etamon test has been made. In a group of 94 patients studied by Hinton and Lord<sup>8</sup> an immediate postoperative drop in pressure was obtained in a high percentage of cases that was consistent with the drop obtained with sodium amytal. However, in a significant group no consistent correlation was noted. The effect of autonomic blockade with tetraethylammonium chloride closely parallels the results obtained with sodium amytal.

Smithwick<sup>14</sup> has stated that patients with a hospital diastolic pressure of 140 mm. of mercury and

TABLE 3.—Results for 72\* Hypertensive Patients, Aged 50-59 Years, Subjected to Sympathectomy

Died: In hospital, 4 (5.5 per cent); died of hypertensive vascular disease: in 3 to 6 months, 2; in 7 to 12 months, 3; in 18 to 24 months, 2.

Summary of Diastolic Pressure of 58 Living Patients

Follow-up (months)	6	12	24	30	36	48
Patients .....	10	33	12	1	1	1
Resting, 110....	6(60%)	20(60%)	8(66%)	1	1	0
Exercise, 110..	9(90%)	20(60%)	7(58%)	1	0	0

\*Three patients were not followed.

above do not respond satisfactorily to thoracolumbar sympathectomy. Among 24 males with a diastolic pressure of 140 mm. or higher he reports 20 deaths, three slightly improved, and one markedly improved. The results in our cases in this category are at variance with Smithwick's findings, as shown in Table 2.

De Takats and co-workers<sup>4</sup> have emphasized the importance of operation in patients under 40 years of age having a diastolic pressure not exceeding 120 mm. of mercury. Our experience with the older group would seem worth recording and is presented in Table 3.

#### OPERATIVE PROCEDURE

We place our patients in the exact lateral position with the lower leg flexed and the upper leg extended. The kidney rest is elevated under the lower costal region. The tenth rib is resected subperiosteally in its entirety. The parietal pleura is then carefully reflected from the posterolateral chest wall exposing the diaphragm which is divided in its entirety on the operative side. Retraction of the parietal pleura subdiaphragmatically with contained lung and retroperitoneal fat is facilitated by two large Harrington splanchnic retractors. With the wide exposure, delineation of the greater, lesser and least splanchnic nerves along the lower thoracic and upper lumbar sympathetic chain is not difficult.

The greater splanchnic nerve is divided at its junction with the celiac ganglion. The chain is grasped with a long curved hemostat and carefully dissected from each intercostal artery and vein. The communicating rami are divided several millimeters from each ganglion and the chain is divided just below the third lumbar ganglion. The twelfth ganglion is usually located just above or in the substance of the diaphragm and we have repeatedly noted how attenuated the chain is between the twelfth thoracic and the first lumbar ganglion. The thoracic chain is pursued cephalad until the third ganglion is mobilized and division is carried out above it. In the majority of instances the greater splanchnic nerve has its origin from the thoracic ganglia, sixth, seventh, eighth and ninth. The lesser and least splanchnic nerves are removed as the thoracic chain is mobilized.

One of the interesting findings is the wide variation in the size and distribution of the nerves. The minimum operation in a series of 473 cases included

TABLE 2.—Results in the Cases of 104\* Patients Whose Postoperative Diastolic Pressure Exceeded 150 Mm. of Mercury

Died: In hospital, 13 (12.5 per cent); of hypertensive vascular disease: in 3 to 11 months postoperatively, 8; within 18 months, 1.

Mean Postoperative Diastolic Pressures

	Follow-up	
	One Year	Two Years
Resting .....	123 mm. (39 patients)	129 mm. (17 patients)
Exercise .....	117 mm. (35 patients)	121 mm. (15 patients)

\*Five patients were not followed.

nine thoracic ganglia through the second lumbar ganglion with removal of the greater, lesser and least splanchnic nerves. This was done in about 35 per cent of the cases reported. The operative procedure is now much more extensive. In about 40 cases we have included the stellate ganglion through the third lumbar ganglion with all the splanchnic nerves. The minimal operative procedure as we do it now includes the third thoracic ganglion through the third lumbar ganglion with all the splanchnic nerves. It is obvious that the more radical the operation the higher the mortality, but also the better the end results.

#### PRECAUTIONARY MEASURES

As a result of our experience with 473 patients subjected to the two-stage thoracolumbar sympathectomy during the past six years, or from February 1942 to February 1948, certain principles of management during the operative and postoperative periods have evolved. The patients need every possible support to bring them through without a serious complication due either to their disease—for example, coronary occlusion, heart failure, cerebral accident or renal failure—or to a complication of thoracotomy such as pleural effusion, pneumothorax, atelectasis or pneumonia.

There are two basic problems to be handled during the operative and early postoperative periods: first, the maintenance of adequate blood pressure, thereby avoiding a sharp drop in systolic pressure to levels of 100 mm. of mercury or lower, which may occur with alarming suddenness, especially during and after the second stage procedure; and, secondly, the management of the thoracotomy during and after operation. The maintenance of a relatively stable systolic pressure has been best achieved by the use of 2 cc. of a 1 per cent solution of neosynephrine in 1,000 cc. of 5 per cent glucose in distilled water administered intravenously during the operation; and postoperatively, by using the same fluid with 1 cc. of neosynephrine per 1,000 cc. of solution until the systolic blood pressure has become stabilized at 90 or 100 mm. of mercury or higher. This may take only a few hours or it may take as long as 48 hours. Before this method was introduced, the anesthetist injected intramuscularly or intravenously 2 or 3 minims of neosynephrine when necessary and the same procedure was used postoperatively.

We have found that moderate anemia develops after each stage of the extensive sympathectomy, probably due to oozing into the extrapleural and intrapleural spaces during the early postoperative period. For this reason a 500 cc. blood transfusion is routinely given during the operative procedure and another 500 cc. transfusion immediately after the first stage and 1,000 cc. after the second stage.

The second major problem is to secure hemostasis and to deal with the open thorax during the operation and to prevent serious hemothorax, pneumothorax, atelectasis, and pneumonia postoperatively. Grimson<sup>5</sup> has recently stated his position as follows:

A closed anesthetic system is employed, with an intratracheal tube used only occasionally. The pleural cavity is deliberately entered through a partial third rib resection and longer tenth rib resection and the chain removed from the stellate ganglion through L-1 and L-2 inclusive, followed by the use of a closed tube suction drainage of the pleural cavity for two or three days.

We also have made use of a closed anesthetic system, usually with an endotracheal tube. Recently we have begun a series without such a tube and the management in the hands of experienced anesthetists has been for the most part satisfactory. One point should be emphasized: this extensive sympathectomy should be carried out only when an anesthetist thoroughly familiar with open chest operative procedures is conducting the anesthesia. Although in our technique the parietal pleura is stripped from the chest wall from the diaphragm to the apex of the thorax, it is usually torn to a greater or lesser extent so that air readily passes into the intrapleural space. The anesthetic agents used have been ether, cyclopropane, and ethylene, and indications and contraindications for them may be found in reports by Phelps and Burdick<sup>11</sup> and Burdick, Phelps, and Peterson.<sup>2</sup>

Hemostasis is not a simple matter in this procedure, and one of the frequent complications has been development of fluid in the chest postoperatively. Grimson<sup>5</sup> has had a similar difficulty by his method of approach. In addition to the clamp and ligature, there are at one's disposal temporary pressure on the venous bleeder against the vertebral column, which is often satisfactory; silver clips, oxycel and other hemostatic absorbable agents, bone wax, and finally electrocautery. We have not used the last mentioned because of the fear of an explosion in the presence of such potentially dangerous anesthetic agents and the open pleura. The most serious difficulty with hemorrhage is presented by an accidental tear of an intercostal artery high in the chest cavity such as the third, fourth, or fifth. When hemostasis has been secured following the removal of the sympathetic chain and suture of the diaphragm, the chest wall is closed around a large rubber catheter placed into the pleural space. Air is completely aspirated, the catheter removed and the skin closed without drainage.

During the entire postoperative period, but particularly during the first 48 hours, careful, repeated, bedside examination of the chest must be made. Signs of fluid and/or atelectasis (usually due to fluid) are promptly checked by a portable x-ray of the chest and aspiration with a large (number 15) needle carried out. In patients with poor cardiac reserve, pleural effusion (usually hemorrhagic) may be of the gravest significance and prompt recognition and treatment may be life-saving.

#### RESULTS

Although only one aspect of the disease complex is represented in blood pressure readings they are useful as measurable end points. This is especially

true of the diastolic pressure. Accordingly, we have summarized the results in 164 patients first by considering only the diastolic pressures, and by arbitrarily dividing our patients into two groups, those who had postoperative diastolic pressure below 110 mm. of mercury and those who had diastolic pressure above that level. From this point of view, those in the latter group were considered to have a less than satisfactory result. Of the 164 patients followed for one year 93 had diastolic pressure of 110 mm. or lower and 71 had diastolic pressure above 110 mm. A somewhat more dramatic response is demonstrated after exercise and is more steadily maintained for a longer period. We have been impressed by the number of patients whose postoperative diastolic blood pressure falls sharply after exercise, even when the resting pressure has been at higher levels. That this does not necessarily represent a good parallel with the effect to be expected from everyday stress and strain was apparent from the fact that frequently such sharp drops were seen in patients whose blood pressure, taken immediately after their walk or taxi ride to an appointment with the physician, was at higher levels. However, this paradoxical effect carries with it implications of benefit in those patients in whom vascular accidents might be anticipated if they were subjected to unaccustomed physical strain. The mechanism of such a drop in pressure may well be the result of peripheral dilatation in the muscle bed, unopposed as in the intact organism, by splanchnic constriction, thus averting the customary summated response of blood pressure elevation, as in the routine preoperative response to exercise. The distribution of diastolic pressure drops, which is indicated in Table 3, demonstrates the significant difference between the resting and exercise results six months following sympathectomy.

#### RESULTS IN 104 PATIENTS WITH PREOPERATIVE DIASTOLIC PRESSURES ABOVE 150 MM. OF MERCURY

A review of 104 patients whose preoperative diastolic pressures consistently ranged above 150 mm. of mercury is detailed in Table 2. In this group, as might be expected, the immediate hospital mortality is significantly increased. The total number of deaths in the follow-up period at hand is high, but the number of patients followed for more than six months is so small that further conclusions must be deferred. The range of diastolic pressure results is so broad as to preclude critical analysis from the point of view of preoperative prognosis.

That relatively advanced age is not necessarily a contraindication to thoracolumbar sympathectomy is readily appreciated in reviewing the data in Table 3 which represents the operative results in a group of 72 patients from 50 to 59 years of age. The hospital death rate was lower than that of the group as a whole, and the two-year follow-up reveals a large percentage of the patients continuing to maintain a satisfactory diastolic level. Although this group would ordinarily be expected to include a

higher percentage of patients with organic vascular changes, intensive clinical study was undertaken to eliminate those with such changes and undoubtedly the results in this group are highly colored by fortunate clinical preoperative evaluation.

#### TOXEMIA OF PREGNANCY

We do not have at hand data in a sufficiently adequate series to formulate an opinion on the relation of hypertension to the toxemia of pregnancy and the operative results. Of interest, however, are the cases of two young women in their early twenties. One, who had well documented hypertension of undetermined cause, following operation went through a full term of pregnancy with blood pressure entirely normal. The other developed hypertension during a previous pregnancy in the course of mild toxemia, her subsequent blood pressure being in the range of 130 mm. of mercury systolic and 140 mm. diastolic. One year following the day a second stage operation was completed she was delivered of a full term viable infant, having had normal blood pressure throughout her pregnancy. These are, of course, isolated observations, but are noted for their clinical interest.

#### SUBJECTIVE RESULTS

From the clinical point of view a most important consideration in the evaluation of any therapeutic procedure is the subjective result obtained. Our experience has paralleled that of others, in that we have consistently been impressed by the subjective improvement and the disappearance of severe and often disabling symptoms irrespective of the effect on the blood pressure. In obtaining these opinions from our patients, in all instances, a nurse-technician has asked them, among other questions, "Has the operation, in your opinion, benefited you?" Many factors enter into such a personal reaction. The patients may have had such a miserable postoperative course that the natural recovery from its severe discomfort leaves them certain that they are now better. Less easy to discount is the almost inevitable relief from pounding headaches and a sense of "relief from tension" not unlike that sensation so often described by patients who have undergone subtotal thyroidectomy for hypertension. Details

TABLE 4.—*Subjective and Objective End Results of Operation\**

No. of Patients	Follow-up Period (Mos.)	Subjective Improvement		Marked and Moderate Objective Improvement	
215	6	163	76%	.....	.....
148	12	123	83%	.....	.....
76	18	62	81%	.....	.....
62	24	50	80%	.....	.....
152	6	.....	.....	123	81%
69	12	.....	.....	62	90%
31	18	.....	.....	28	90%
15	24	.....	.....	11	73%
8	36	.....	.....	8	100%

\*This evaluation is based on postoperative blood pressure: Electrocardiographic readings, heart x-ray, blood chemistry, urinalysis, and symptomatic improvement.

of the subjective results among 215 patients are tabulated in Table 4 and compared with objective improvement in 152 patients of another group.

#### THE OVER-ALL PICTURE

As noted in reviewing the cases of patients in the older age group, the final selection of patients for operation is highly colored by what, for lack of a more suitable term, we call clinical judgment. Difficult though this is to define quantitatively, nevertheless the clinical impression of a patient to some extent equals the sum of the effects of the disease processes at work plus the evidence of the force of the patient's particular psychologic and physiologic factors working in opposition to the disease processes. It is a common clinical observation that there are times when the patient looks better than the chart would indicate he should, and vice versa. We feel that most clinicians will agree, especially in the face of equivocal or conflicting laboratory findings, that such an over-all evaluation of the patient must continue to play a significant part in the final decision for or against operation.

Whether complete or nearly complete sympathectomy is preferable to a less extensive operative procedure, has not as yet been determined. In the first two years, we followed the typical Smithwick procedure from T-9 through L-2, but after doing this in approximately 150 cases we gradually extended the procedure. For the past three years the minimal operative procedure has been from T-3 through D-3, and during this time we have also done about 40 total sympathectomies which included the stellate ganglion. The results of some cases (with a complete follow-up) in which the more radical operative procedure was carried out, as compared with results following the lesser procedure, are summarized in Tables 5, 6, and 7. There can be no conclusion that the more radical procedure is preferable until the patients have been observed for a longer follow-up period.

Moreover, as the mortality rate from the more extensive operation is double that from the lesser, this would have to be weighed against end results in forming an opinion as to the relative merits of the two.

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#### REFERENCES

1. Adson, A. W.: Indications for operations on sympathetic nervous system, *J.A.M.A.*, 106:360 (Feb. 1), 1936.
2. Adson, A. W., Craig, W. McK., and Brown, G. E.: Surgery in its relation to hypertension, *Surg. Gynec. & Obst.*, 62:314 (Feb.), 1936.
3. Burdick, D. L., Phelps, McK. L., and Peterson, M. C.: Anesthesia for sympathectomy in hypertension, *N. Y. State J. Med.*, 46:2139 (Oct.), 1946.
4. Crile, G.: Surgical treatment of essential hypertension, *Cleveland Cl. Quarterly*, 3:201 (July), 1936.
5. DeTakats G., et al: Surgical approach to hypertension: second report, *Arch. of Surg.*, Vol. 5 (Aug.), 1946.
6. Grimson, K.: Symposium on aseptic surgical technic and its application to thoracic surgery; complications of thoracotomy observed during operations upon sympathetic and vagus nerves, *Surg. Cl. of No. Amer.*, 26:118 (Oct.), 1946.
6. Heuer, G. J., and Page, I. H.: Treatment of essential and malignant hypertension by section of anterior nerve roots, *Arch. Int. Med.*, 59:245 (Feb.), 1937.
7. Hinton, J. W.: *Conn. State Med. Jour.* (Oct.), 1947.
8. Hinton, J. W.: Operative technique of thoracolumbar sympathectomy, *Surg. Gynec. and Obstet.*, 84:643 (Nov.), 1946.
9. Keith, N. M., Wagener, H. P., and Barker, N. W.: Some different types of surgical hypertension; their course and prognosis, *Am. J. M. Sc.*, 197:332 (Mar.), 1939.
10. Peet, M. M.: Surgical treatment of hypertension, *Proc. Calif. Ac. of Med.*, page 58, 1937.
11. Phelps, McK. L., and Burdick, D. L.: Anesthetic management of patients undergoing sympathectomy for hypertension, *Anesthesiology*, 4:361 (July), 1943.
12. Poindexter, C., and Tamagna, I.: To be published.
13. Smithwick, R. H.: Technique for splanchnic resection for hypertension; preliminary report, *Surgery*, 7:10 (Jan.), 1940.

TABLE 5.—Number of Cases in Which the Postoperative Diastolic Blood Pressure Is Below 100 mm. of Mercury (One Year Follow-up)

Operation	Total	Number Below 100	Per Cent
T-8 or T-9 through L-2 or L-3.....	69	18	26
T-3 or T-4 through L-2 or L-3.....	48	26	54

Table 5 compares the effect of the Smithwick procedure and the extensive sympathectomy on the postoperative diastolic blood pressure. In each patient the resting and post-exercise diastolic blood pressure have been averaged. Only one-fourth of the patients following less extensive operation had diastolic blood pressure levels below 100 mm. of mercury. On the other hand, more than one-half of the patients had diastolic pressures below 100 mm. of mercury following the extensive operation. The vast majority of patients in both groups had preoperative diastolic pressures of 125 mm. of mercury or more.

TABLE 6.—Number of Cases Obtaining Smithwick Groups I and II Diastolic Blood Pressure Result (One Year Follow-up)

Operation	Total	Number of Groups I and II	Per Cent
T-8 or T-9 through L-2 or L-3.....	69	33	48
T-3 or T-4 through L-2 or L-3.....	48	36	75

Table 6 shows the relative percentages of Group I and Group II Smithwick diastolic blood pressure results. A Group I result represents a fall of 30 points or more from the preoperative diastolic pressure and a Group II result represents a fall of 20 to 29 points. Again it is clear that the extensive operation is more effective in lowering the blood pressure.

TABLE 7.—In-Hospital Mortality Rate in 100 Consecutive Cases in Each Group

Operation	Number of Cases	Deaths	Per Cent
T-8 or T-9 through L-2 or L-3.....	100	3	3
T-3 or T-4 through L-2 or L-3.....	100	6	6

Finally in Table 7 the number of deaths in the hospital in 100 consecutive cases in each group are compared. In both of these series the operations were done before the establishment of a set of rules which have proved helpful in the elimination of the majority of bad-risk patients. If the rules had been employed in the above two series the mortality rates would have been halved. We are fully aware that experienced and sound clinical judgment must go hand in hand with the practical application of the rules.